DIRECTORY OF
CALIBRATION SERVICES FOR
IONIZING RADIATION SURVEY INSTRUMENTS

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Prepared by

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

and the

CONFERENCE OF RADIATION CONTROL PROGRAM DIRECTORS, Inc.

January 1988
NBS GCR 88-539

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Abstract

This directory provides information about calibration services for ionizing radiation survey instruments. Its basic purpose is to tell the owner or user of a survey instrument where a calibration might be obtained. After introductory definitions of critical terms and a general description of quality assurance programs, available calibration services are listed. First, a summary of services is provided in which companies are listed alphabetically by company name and also alphabetically by state. Then a detailed list of services is provided for each type of radiation used to perform a calibration: alpha particles, beta particles, gamma rays, neutrons, and x rays. The final list shows the name, address, phone number, and person to contact for each company included in the directory. Information is presented as provided in a questionnaire returned by each company. No attempt has been made to verify the information provided, and inclusion of a company in the directory does not constitute endorsement by the publisher or approval by any licensing authority.

Foreword

The first edition of this directory, published in 1980, provided a compendium of companies and individuals who could provide calibrations of ionizing radiation survey instruments. The Conference of Radiation Control Program Directors (CRCPD), again through its Committee on Radiation Measurements, in cooperation with the National Bureau of Standards (NBS) has updated this directory with the intent of providing a current document.

The directory was compiled from the results of a questionnaire sent to the companies in May of 1985. A second mailing was made in July 1985 to those who failed to respond to the first questionnaire. The data received have been adapted to comply with the new format of the directory, and were reconfirmed by the companies in May 1987.

NEITHER THE CRCPD NOR THE NBS HAS VERIFIED THE INFORMATION PRESENTED IN THIS DIRECTORY. INCLUSION OF A COMPANY OR ITS SERVICE IN THIS DIRECTORY DOES NOT CONSTITUTE AN ENDORSEMENT BY EITHER ORGANIZATION OF THAT COMPANY OR SERVICE. NEITHER ORGANIZATION ACCEPTS RESPONSIBILITY FOR THE ACCURACY OF THE SERVICE OR REPORTS OF ANY SERVICES BY A COMPANY INCLUDED IN THIS DIRECTORY.

In addition to NOT being endorsed by either the CRCPD or the NBS, the inclusion of a company in the directory does not mean that the company's calibration procedure has been approved by the appropriate licensing authority or that the accuracy statement is compatible with the current or proposed requirements of the appropriate licensing authority.

Members of the Committee preparing this directory included:

Robert L. Craig, Emeritus, Oklahoma, Chairman (1980-1983)
Frank Cosolito, New Jersey
Paul Eastvold, Illinois, Chairman (1983-1985)
Lawrence McDonnell, Wisconsin
Marshall W. Parrott, Emeritus, Oregon, Chairman (1986)

The Federal Resource Personnel that participated in the preparation of the directory included:

Elmer Eisenhower, National Bureau of Standards
Henry T. Heaton, II, National Bureau of Standards
Thomas Ohlhaber, Center for Devices and Radiological Health
Sean Soong, Nuclear Regulatory Commission

Definitions of Terms

Accuracy - The degree of agreement of an observed value (i.e., the value indicated by a measurement) with the true value of the quantity being measured. It is usually expressed in percent and is calculated as

$$\text{accuracy} = \frac{\text{mean observed value - true value}}{\text{true value}} \times 100\%$$

Small percentages indicate good accuracy and large percentages indicate poor accuracy.

The accuracy values shown in the tables of this directory refer only to the accuracy of the calibration process used by a particular company, and do not refer to the inherent accuracy of the survey instrument being calibrated. The values shown in the tables indicate the accuracy to which the radiation field used for calibration is known.

Calibration (of an instrument) - A comparison of the response of a given instrument with the response of a transfer standard instrument when both are exposed to the same radiation source under the same conditions; or the determination of the response of the given instrument when exposed to the output of a transfer standard source under well defined conditions.

Note: This definition requires exposure of an instrument's detector to a radiation field. A check of only the instrument's electronic circuitry is not considered to be a calibration.

Survey instrument - A hand-held instrument used to measure ionizing radiation for purposes of radiation protection. It includes instruments used for emergency response and for measurement of radiation beams in non-therapeutic applications. It does not include instruments designed as area, portal, or personnel monitors, as monitors of radioactive gases or airborne particulates, or as dose or beam calibrators for therapeutic applications.

Transfer standard - A physical measurement standard that has been compared directly or indirectly with the appropriate national standard. It is typically a measurement instrument or a radiation source used as a reference.

Symbols and Abbreviations

A/m - alphas per minute
A/s - alphas per second
B/m - betas per minute
B/s - betas per second
Ci - curie

cm - centimeter
cm^2 - centimeters squared
cpm - counts per minute
CRCPD - Conference of Radiation Control Program Directors
d - day
dia - diameter
dpm - disintegrations per minute
dps - disintegrations per second
D2O - deuterium oxide (heavy water)
G-M - Geiger-Müller detector
> - greater than
h - hour
HVL - half-value layer
in - inch
keV - thousand electron volts
kVp - kilovolts peak (potential)
m^3 - meters cubed
mCi - millicurie (10^{-3} curie)
MeV - million electron volts
mfr - manufacturer
μCi - microcurie (10^{-6} curie)
μR - microroentgen (10^{-6} roentgen)
mm - millimeter
mR - milliroentgen (10^{-3} roentgen)
mR/h - milliroentgen per hour
mR/h @ 1 m - milliroentgen per hour at one meter
mrad - millirad (10^{-3} rad)
mrem/h - millirem per hour
MV - million volts
min - minute
N - no
nCi - nanocurie (10^{-9} curie)
n/cm^2/s - neutrons per square centimeter per second
PIC - pressurized ionization chamber
R - roentgen
R/h - roentgen per hour
R/m - roentgen per minute
s - second
y - year
Y - yes

Quality Assurance

The calibration accuracies shown in the tables of this directory are the values reported by the companies in their questionnaires. Each company was provided an expanded definition of "accuracy" consistent with the shorter definition in the previous section of this directory, and was asked to report its best estimate of that value for its calibration service. In nearly all cases, that estimated accuracy has not been verified by a performance test of the company. Mechanisms for such performance tests are not generally available at this time, but are under development.

The National Bureau of Standards, in collaboration with various national organizations and laboratories, is in the process of developing a system of secondary standards laboratories that will meet specified requirements for measurement quality assurance. When those requirements are met by a candidate laboratory, accreditation may be granted by an appropriate participating organization. The key requirements for such recognition of competence are:

- Satisfaction of general operational criteria (facility, equipment, staff, etc.);

- Periodic performance tests by a higher-level laboratory;

- An acceptable internal quality control program, with records of quality control actions; and

- Documented procedures for providing calibrations to customers.

At the present time, two national programs are operational that have limited relevance for commercial laboratories that calibrate survey instruments. The first is a program under which the American Association of Physicists in Medicine accredits laboratories that calibrate instruments used, in turn, to calibrate radiation therapy beams. Five laboratories are accredited and no additional applications will be considered by the AAPM at this time. The second program involves accreditation of state-operated laboratories that calibrate instruments used for radiation protection and measurement of diagnostic x-ray beams. Three laboratories are presently accredited by the Conference of Radiation Control Program Directors and two more are expected to be accredited in the future.

In June 1986 the executive board of the Health Physics Society approved the implementation of a national program whereby it will accredit laboratories that calibrate survey instruments. This program is an outgrowth of a workshop held by NBS in July 1984 and was developed in response to demand from the radiation protection community. The Society plans to accredit laboratories at the secondary and tertiary levels, using technical criteria developed collaboratively with NBS to evaluate their qualifications and performance. It is expected that a number of the companies listed in this directory will become accredited by the

Society. This program became operational in 1987, but no accreditations had yet been granted at the time this directory was published.

Future editions of this directory will identify those companies that are accredited under the three programs mentioned above.

Directory Organization

The information contained in this directory is based on the replies to questionnaires sent to companies identified as potentially offering calibration services for survey instruments. The only changes to the replies were to convert to a consistent set of prefixes for the units of the radiation quantities and to eliminate comments that companies limit their calibration services to the types of sources they possess.

To provide maximum flexibility in the use of this directory, the information is grouped in three sets of tables: (1) summary of services, (2) calibration information for each of the radiation sources the company possesses, and (3) company and contact identification. In some tables, all the information is listed alphabetically by company name while in other tables it is first separated by state with the companies listed alphabetically within each state. The latter listings are useful if one wants to find companies in a certain region so that the survey instruments can be hand-delivered. In the first two groups of tables, identification information consists of the company name and state with the complete company identification being given only in the last set of tables. All of the tables extend across facing pages.

The first set of tables provides summary information on the types of calibration services offered by each company. In the first set, the first table lists the companies alphabetically while the second table lists the companies by state alphabetically within the state. Otherwise the content of the two tables is the same. In all tables, an "N" means no and a "Y" means yes. The first two columns give the company name and state. Columns 3, 4, and 5 indicate whether the company limits its calibration services to instruments from a particular manufacturer or to particular instrument types together with any limitations. The next three columns provide information on any instrument repair services the company offers. Column 6 indicates whether the company offers any repair service, column 7 whether the repair service is limited, and column 8 how the repair service is limited. The next five columns indicate the number of different sources for each of the five radiation types each company possesses and the last column indicates whether the company offers electronics check services in addition to radiation calibration. Information on the number of sources of each radiation type is useful if it is desired to calibrate the instrument at many different energies. For a given type of radiation, a source was included in the list if it had a different energy, a different calibration method, or a different accuracy. If it were necessary to use two or more essentially identical sources to cover the specified intensity range, then these sources were recorded as a single entry. All x-ray beams produced by the same unit were counted as a single source with the exception that each fluorescent x-ray beam was counted as a separate source.

The second set of tables provides detailed information on each source the company uses for calibration. In all of these tables, the companies are first listed by state and then alphabetically within the state. The tables are categorized by five types of radiation: alpha, beta, gamma, neutron, and x-ray. Since different information is necessary to specify the calibration conditions for each radiation type, specific details on the content of each table are given just before that radiation type. To save space on these tables, information on the radiation sources used by the various companies is also listed just before each radiation type. For each radionuclide, these tables give the half-life, the decay product energies, and the percent of decays for each branch. However, only energies greater than 10 keV and which occur in more than 5% of the decays are listed. For beta particles, both the average and maximum energies are given. For neutrons, only information on the type of reaction producing the neutron spectrum is specified. In general, the (alpha,neutron) reaction results in a broad spectrum extending to about 10 MeV, fission spectra have a mean energy about 2 MeV and moderated spectra will have a lower-energy component. Since several companies identify their x-ray beams using the equivalent NBS beam code, information on these beams is provided in the x-ray section.

The last set of tables provides alphabetical company information including street address, city, state, zip code, phone number, and person to contact for additional information.

Summary of Calibration Services (Alphabetical)

Line Number	Company Name	State	Service Limited to		Service limitations
			Mfr.	Type	
1	Amersham Corp.	TX	N	Y	Industrial Gamma Radiography Use
2	Amersham Corp.	MA	N	Y	Industrial Gamma Radiography Use
3	Applied Health Physics, Inc.	PA	N	N	
4	University of Arkansas	AR	N	Y	Neutron Remmeters
5	Atomic Energy Industrial Lab of the Southwest,Inc.	TX	N	N	
6	Baird Corporation	MA	Y	Y	Baird Corp. Manufactured
7	Ralph M. Baltzo	WA	N	N	
8	Battelle, Pacific Northwest Laboratory	WA	N	N	
9	H. Thomas Bennett	AR	N	Y	G-M, Ion Chambers
10	Bicron Corporation	OH	N	N	
11	Bio Med Associates, Inc.	NJ	N	N	
12	Calib-Ray, Ltd.	NC	N	N	
13	Capintec Instruments, Inc.	PA	Y	Y	Capintec Dose Instruments
14	Certified Testing Laboratories, Inc.	NY	N	N	
15	Don L. Collins & Associates	CA	N	N	
16	Conam Inspection	IL	N	N	
17	Conam Inspection	MN	N	N	
18	Conam Inspection	OH	N	N	
19	Conam Inspection	PA	N	N	
20	Conam Inspection	TX	N	N	
21	E. Lewis Cook & Associates, Inc.	TN	N	N	
22	John F. Domatti, Inc.	TX	N	N	
23	Dosimeter Corporation	OH	Y	N	Dosimeter Corporation products
24	Eberline Instrument Corporation	NM	Y	N	Eberline Manufactured
25	Eberline Instrument Corporation	SC	Y	N	Eberline Manufactured
26	C. E. Epperson	AR	N	N	
27	General Dynamics Services Company	CT	N	N	
28	GNI Incorporated	TX	N	N	
29	Don Hamner	AL	N	N	
30	Chris M. Hearn	KS	N	Y	
31	Health Physics Assoc., Ltd.	IL	N	N	
32	Health Physics Instruments, Inc.	CA	N	N	
33	Health Physics Northwest	OR	N	N	
34	Health Physics Services, Inc.	MD	N	N	
35	W. H. Henken Industries, Inc.	TX	N	N	
36	Stan A. Huber Consultants, Inc.	IL	N	N	
37	Geoffrey S. Ibbott	CO	N	N	
38	INDELCO, INC.	WA	N	N	
39	Industrial Radiography Maintenance & Supply Co,Inc.	LA	N	N	
40	Ionizing Radiation Services	MS	N	N	
41	A. Jacobson & Associates, Inc.	KY	N	N	
42	Johnston Laboratories	MD	Y	Y	Johnston Gas Monitors
43	K & S Associates, Inc.	TN	N	N	
44	Keithley Instruments, Inc.	OH	Y	Y	Keithley Ion Chamber
45	Kenzac Communications Service	TX	N	N	

Summary of Calibration Services (Alphabetical)

Offer Repair Services	Repair Services Limited	Repair service limitations	Alpha	Beta	Gamma	Neutron	Xray	Electronics Check Services	Line Number
Y	Y	Within Warranty			1				1
Y	Y	Within Warranty Returned to Mfr.			1				2
Y	N		2	2	2			Y	3
N						2			4
Y	N		1		2			Y	5
Y	N				1			Y	6
Y	Y		1	6	7				7
Y	Y	Only for Those Cal. at Lab		6	2	2	9	Y	8
N					2				9
Y	Y	Bicron Manufactured			1			Y	10
Y	N				2			Y	11
N					1				12
Y	N				1		1	Y	13
Y	N				1			Y	14
Y	N		2	6	4			Y	15
Y	N				1				16
Y	N				1				17
Y	N				1				18
Y	N				1				19
Y	N				1		1		20
Y	Y	Need circuit diagram			1				21
Y	N				1				22
Y	Y	Dosimeter Corp. manufactured			2		1	Y	23
Y	N		3	2	3	1		Y	24
Y	N		3	2	1	1		Y	25
N			1	2	2				26
Y	Y	Availability of Parts from Mfr.	1	2	2	2		Y	27
Y	N				1			Y	28
N					1				29
Y	N				1		2	Y	30
Y	N		1	6	5			Y	31
Y	N		3	4	2	1	1		32
Y	N		2	1	1			Y	33
Y	Y	Alpha, Beta, Gamma	2	2	3			Y	34
Y	N		2	2	1		1	Y	35
N			3	6	3	2	2		36
N					1		2		37
Y	Y	Parts and Schematics			1			Y	38
Y	N				1				39
Y	Y	3 hr Time Limit			2			Y	40
Y	Y	Mfr. Sealed Components Not Repaired	2	1	2		1		41
Y	N			1				Y	42
Y	Y	Availability of parts, schematic			3			Y	43
Y	N						1	Y	44
Y	N				1				45

Summary of Calibration Services (Alphabetical)

Line			Service Limited to		Service limitations
Number	Company Name	State	Mfr.	Type	
46	Ludlum Measurements, Inc.	TX	N	N	
47	Murray Lures	AR	N	N	
48	Medi-Ray, Inc.	NY	N	N	
49	Medical & Radiation Physics, Inc.	TX	Y	Y	Ludlum, Eberline, Victoreen, Nuclear-Chicago
50	Mid-Atlantic Radiation Physics, Inc.	MD	N	N	
51	Midwest Calibration Center	IL	N	N	
52	Midwest Radiation Protection, Inc.	In	N	N	
53	Jerry D. Morris	MS	N	N	
54	Morrison-Knudsen Co., Inc.	ID	N	N	
55	mR Services, Inc.	CO	N	N	
56	The NDL Organization, Inc.	NY	N	N	
57	Newco, Inc.	SC	N	N	
58	NMA-Medical Physics Services	OH	N	N	
59	Nuclear Consulting Services, Inc.	OH	N	N	
60	Nuclear Instrument Co.	MA	N	N	
61	Nuclear Sources & Services	TX	N	N	
62	Neutron Products, Inc.	MD	N	Y	Range > 10R/h
63	Office of Emergency Services	CA	N	N	
64	Perry Radiological Consulting, Inc.	AL	N	N	
65	Physics Associates	VA	N	N	
66	Professional Radiation Services Corp.	KY	N	N	
67	R/A Services	TX	N	N	
68	Radcal Corp	CA	N	Y	Instruments with cable between probe and readout
69	Radiation Consultants of Mid-America, Inc.	KS	N	N	
70	Radiation Consultants, Inc.	TX	N	N	
71	Radiation Consulting Associates, Inc.	FL	N	N	
72	Radiation Instrument Calibration Laboratory	IL	N	N	
73	Radiation Protection	WA	N	N	
74	Radiation Safety Engineering, Inc.	AZ	N	N	
75	Radiation Safety Services, Inc.	IL	N	N	
76	Radiological Calibration Services, Inc.	SC	N	Y	
77	Radiological Physics Services, Inc.	AZ	N	N	
78	Radiology Association of Macon	GA	N	N	
79	Reuter-Stokes	OH	Y	Y	Reuter-Stokes PIC's
80	St. Mary's Hospital and Medical Center	CO	N	Y	G-M & Ion Chamber Survey Meter
81	Schneider & Wuest, Inc.	OH	N	N	
82	SIMCO Electronics	CA	N	N	
83	G. E. Smith & Associates, Inc.	TX	N	N	
84	Source Production and Equipment Co., Inc.	LA	N	Y	Industrial
85	South Arkansas Radiation Therapy Institute	AR	N	N	
86	Standard Nuclear Consultants, Ltd.	IL	N	N	
87	Sun Nuclear Corporation	FL	N	N	
88	Syncor Instrument Corp.	CA	N	N	
89	Teledyne Isotopes	NJ	N	N	
90	University of Utah	UT	N	Y	G-M, Ionization Chamber
91	University of Washington	WA	N	N	
92	R. M. Wester & Associates, Inc.	MO	N	N	
93	Robert Wilson	TN	N	N	

Summary of Calibration Services (Alphabetical)

Offer Repair Services	Repair Services Limited	Repair service limitations	Alpha	Beta	Gamma	Neutron	Xray	Electronics Check Services	Line Number
Y	Y	Schematics, Unique Features	3	4	8	1		Y	46
N					1				47
N					1				48
N					1				49
N					1			Y	50
Y	N		2	2	2	1		Y	51
N			2	5	3			Y	52
N					2				53
Y	Y	May Require Schematics, Manuals			1				54
Y	Y	Meter&board, Cord, G-M Tube Repl.			1			Y	55
Y	N		1	2	1			Y	56
Y	N				1				57
Y	Y	Batteries, Connectors, etc.			3				58
Y	Y	Availability of Parts	1	1	1			Y	59
Y	N		1	1	2			Y	60
Y	N		2	2	3	3		Y	61
N					1				62
Y	Y	Minor Repairs Only			1		1	Y	63
N				2	1		1		64
N					1				65
Y	N				2				66
Y	N				1				67
Y	Y	Radcal manufactured			2		1	Y	68
Y	N				1				69
Y	N				2				70
Y	N				1			Y	71
N					1		1	Y	72
Y	N		1	2	2	1		Y	73
Y	Y	Ludlum Instruments Only			1			Y	74
Y	N		1	5	1	1	1	Y	75
Y	N				1			Y	76
N					1				77
N				1	1		2		78
Y	N				1			Y	79
N					1				80
Y	N				2				81
Y	N				1			Y	82
Y	N				2			Y	83
Y	Y	Domestic units			1				84
N					1				85
N			2	2	3				86
Y	N				2			Y	87
Y	N				1			Y	88
Y	Y	Battery, Connector Replacement	1	1	1			Y	89
N			1	6	1				90
N					1			Y	91
Y	N				1			Y	92
N					1				93

Summary of Calibration Services (By State)

Line Number	Company Name	State	Service Limited to Mfr.	Service Limited to Type	Service limitations
1	Don Hamner	AL	N	N	
2	Perry Radiological Consulting, Inc.	AL	N	N	
3	University of Arkansas	AR	N	Y	Neutron Remmeters
4	H. Thomas Bennett	AR	N	Y	G-M, Ion Chambers
5	C. E. Epperson	AR	N	N	
6	Murray Lures	AR	N	N	
7	South Arkansas Radiation Therapy Institute	AR	N	N	
8	Radiation Safety Engineering, Inc.	AZ	N	N	
9	Radiological Physics Services, Inc.	AZ	N	N	
10	Don L. Collins & Associates	CA	N	N	
11	Health Physics Instruments, Inc.	CA	N	N	
12	Office of Emergency Services	CA	N	N	
13	Radcal Corp	CA	N	Y	Instruments with cable between probe and readout
14	SIMCO Electronics	CA	N	N	
15	Syncor Instrument Corp.	CA	N	N	
16	Geoffrey S. Ibbott	CO	N	N	
17	mR Services, Inc.	CO	N	N	
18	St. Mary's Hospital and Medical Center	CO	N	Y	G-M & Ion Chamber Survey Meter
19	General Dynamics Services Company	CT	N	N	
20	Radiation Consulting Associates, Inc.	FL	N	N	
21	Sun Nuclear Corporation	FL	N	N	
22	Radiology Association of Macon	GA	N	N	
23	Morrison-Knudsen Co., Inc.	ID	N	N	
24	Conam Inspection	IL	N	N	
25	Health Physics Assoc., Ltd.	IL	N	N	
26	Stan A. Huber Consultants, Inc.	IL	N	N	
27	Midwest Calibration Center	IL	N	N	
28	Radiation Instrument Calibration Laboratory	IL	N	N	
29	Radiation Safety Services, Inc.	IL	N	N	
30	Standard Nuclear Consultants, Ltd.	IL	N	N	
31	Midwest Radiation Protection, Inc.	In.	N	N	
32	Chris M. Hearn	KS	N	Y	
33	Radiation Consultants of Mid-America, Inc.	KS	N	N	
34	A. Jacobson & Associates, Inc.	KY	N	N	
35	Professional Radiation Services Corp.	KY	N	N	
36	Industrial Radiography Maintenance & Supply Co,Inc.	LA	N	N	
37	Source Production and Equipment Co., Inc.	LA	N	Y	Industrial
38	Amersham Corp.	MA	N	Y	Industrial Gamma Radiography Use
39	Baird Corporation	MA	Y	Y	Baird Corp. Manufactured
40	Nuclear Instrument Co.	MA	N	N	
41	Health Physics Services, Inc.	MD	N	N	
42	Johnston Laboratories	MD	Y	Y	Johnston Gas Monitors
43	Mid-Atlantic Radiation Physics, Inc.	MD	N	N	
44	Neutron Products, Inc.	MD	N	Y	Range > 10R/h
45	Conam Inspection	MN	N	N	
46	R. M. Wester & Associates, Inc.	MO	N	N	

Summary of Calibration Services (By State)

Offer Repair Services	Repair Services Limited	Repair service limitations	Alpha	Beta	Gamma	Neutron	Xray	Electronics Check Services	Line Number
N					1				1
N				2	1		1		2
N						2			3
N					2				4
N			1	2	2				5
N					1				6
N					1				7
Y	Y	Ludlum Instruments Only			1			Y	8
N					1				9
Y	N		2	6	4			Y	10
Y	N		3	4	2	1	1		11
Y	Y	Minor Repairs Only			1		1	Y	12
Y	Y	Radcal manufactured			2		1	Y	13
Y	N				1			Y	14
Y	N				1			Y	15
N					1		2		16
Y	Y	Meter&board, Cord, G-M Tube Repl.			1			Y	17
N					1				18
Y	Y	Availability of Parts from Mfr.	1	2	2	2		Y	19
Y	N				1			Y	20
Y	N				2			Y	21
N				1	1		2		22
Y	Y	May Require Schematics, Manuals			1				23
Y	N				1				24
Y	N		1	6	5			Y	25
N			3	6	3	2	2		26
Y	N		2	2	2	1		Y	27
N					1		1	Y	28
Y	N		1	5	1	1	1	Y	29
N			2	2	3				30
N			2	5	3			Y	31
Y	N				1		2	Y	32
Y	N				1				33
Y	Y	Mfr. Sealed Components Not Repaired	2	1	2		1		34
Y	N				2				35
Y	N				1				36
Y	Y	Domestic units			1				37
Y	Y	Within Warranty Returned to Mfr.			1				38
Y	N				1			Y	39
Y	N		1	1	2			Y	40
Y	Y	Alpha, Beta, Gamma	2	2	3			Y	41
Y	N			1				Y	42
N					1			Y	43
N					1				44
Y	N				1				45
Y	N				1			Y	46

Summary of Calibration Services (By State)

Line Number	Company Name	State	Service Limited to		Service limitations
			Mfr.	Type	
47	Ionizing Radiation Services	MS	N	N	
48	Jerry O. Morris	MS	N	N	
49	Calib-Ray, Ltd.	NC	N	N	
50	Bio Med Associates, Inc.	NJ	N	N	
51	Teledyne Isotopes	NJ	N	N	
52	Eberline Instrument Corporation	NM	Y	N	Eberline Manufactured
53	Certified Testing Laboratories, Inc.	NY	N	N	
54	Medi-Ray, Inc.	NY	N	N	
55	The NDL Organization, Inc.	NY	N	N	
56	Bicron Corporation	OH	N	N	
57	Conam Inspection	OH	N	N	
58	Dosimeter Corporation	OH	Y	N	Dosimeter Corporation products
59	Keithley Instruments, Inc.	OH	Y	Y	Keithley Ion Chamber
60	NMA-Medical Physics Services	OH	Y	N	
61	Nuclear Consulting Services, Inc.	OH	N	N	
62	Reuter-Stokes	OH	Y	Y	Reuter-Stokes PIC's
63	Schneider & Wuest, Inc.	OH	N	N	
64	Health Physics Northwest	OR	N	N	
65	Applied Health Physics, Inc.	PA	N	N	
66	Capintec Instruments, Inc.	PA	Y	Y	Capintec Dose Instruments
67	Conam Inspection	PA	N	N	
68	Eberline Instrument Corporation	SC	Y	N	Eberline Manufactured
69	Newco, Inc.	SC	N	N	
70	Radiological Calibration Services, Inc.	SC	N	Y	
71	E. Lewis Cook & Associates, Inc.	TN	N	N	
72	K & S Associates, Inc.	TN	N	N	
73	Robert Wilson	TN	N	N	
74	Amersham Corp.	TX	N	Y	Industrial Gamma Radiography Use
75	Atomic Energy Industrial Lab of the Southwest,Inc.	TX	N	N	
76	Conam Inspection	TX	N	N	
77	John F. Domatti, Inc.	TX	N	N	
78	GNI Incorporated	TX	N	N	
79	W. H. Henken Industries, Inc.	TX	N	N	
80	Kenzac Communications Service	TX	N	N	
81	Ludlum Measurements, Inc.	TX	N	N	
82	Medical & Radiation Physics, Inc.	TX	Y	Y	Ludlum, Eberline, Victoreen, Nuclear-Chicago
83	Nuclear Sources & Services	TX	N	N	
84	R/A Services	TX	N	N	
85	Radiation Consultants, Inc.	TX	N	N	
86	G. E. Smith & Associates, Inc.	TX	N	N	
87	University of Utah	UT	N	Y	G-M, Ionization Chamber
88	Physics Associates	VA	N	N	
89	Ralph M. Baltzo	WA	N	N	
90	Battelle, Pacific Northwest Laboratory	WA	N	N	
91	INDELCO, INC.	WA	N	N	
92	Radiation Protection	WA	N	N	
93	University of Washington	WA	N	N	

Summary of Calibration Services (By State)

Offer Repair Services	Repair Services Limited	Repair service limitations	Alpha	Beta	Gamma	Neutron	Xray	Electronics Check Services	Line Number
Y	Y	3 hr Time Limit			2			Y	47
N					2				48
N					1				49
Y	N				2			Y	50
Y	Y	Battery, Connector Replacement	1	1	1			Y	51
Y	N		3	2	3	1		Y	52
Y	N				1			Y	53
N					1				54
Y	N		1	2	1			Y	55
Y	Y	Bicron Manufactured			1			Y	56
Y	N				1				57
Y	Y	Dosimeter Corp. manufactured			2		1	Y	58
Y	N						1	Y	59
Y	Y	Batteries, Connectors, etc.			3				60
Y	Y	Availability of Parts	1	1	1			Y	61
Y	N				1			Y	62
Y	N				2				63
Y	N		2	1	1			Y	64
Y	N		2	2	2			Y	65
Y	N				1		1	Y	66
Y	N				1				67
Y	N		3	2	1	1		Y	68
Y	N				1				69
Y	N				1			Y	70
Y	Y	Need circuit diagram			1				71
Y	Y	Availability of parts, schematics			3			Y	72
N					1				73
Y	Y	Within Warranty			1				74
Y	N		1		2			Y	75
Y	N				1		1		76
Y	N				1				77
Y	N				1			Y	78
Y	N		2	2	1		1	Y	79
Y	N				1				80
Y	Y	Schematics, Unique Features	3	4	8	1		Y	81
N					1				82
Y	N		2	2	3	3		Y	83
Y	N				1				84
Y	N				2				85
Y	N				2			Y	86
N			1	6	1				87
N					1				88
Y	Y		1	6	7				89
Y	Y	Only for Those Cal. at Lab		6	2	2	9	Y	90
Y	Y	Parts and Schematics			1			Y	91
Y	N		1	2	2	1		Y	92
N					1			Y	93

ALPHA-PARTICLE SOURCES(1)

Source	Half-Life (years)	Energy (MeV)	Occurrence(2) (%)
230-Th	7.7 E4	4.621	23.4
		4.688	76.3
235-U	7.04 E8	4.217	5.7
		4.364	11.
		4.370	6.
		4.396	55.
		4.598	5.0
238-U	4.47 E9	4.147	23.
		4.196	77.
238-Pu	87.8	5.457	28.3
		5.499	71.6
239-Pu	2.41 E4	5.105	11.5
		5.143	15.1
		5.155	73.3
241-Am	432.	5.443	12.8
		5.486	85.2

(1) **Table of Isotopes, Seventh Edition**, 1978, (Eds. C. Michael Lederer and Virginia S. Sherly) John Wiley and Sons, New York, NY

(2) Only lists alpha branches which occur at least 5% of the time.

CALIBRATION SERVICES USING ALPHA PARTICLES

The first three columns provide the normal identification information. The next two columns list the particular alpha emitting radionuclides the company has available for calibrating instruments together with information on the geometry of the particular source. The next three columns provide information on the range of intensities available for calibration together with the units used. When a lower range was specified, usually more than one source was used. The number of essentially identical sources is recorded under the "Comments" column. If no intensity range was specified, it was only recorded under the Intensity (High) column as the maximum value. In column 8, A/m represents alphas/min. No attempt was made to convert either dpm or cpm to activity. Using a keyed code, column 9 indicates what calibration method(s) the company used to calibrate alpha measuring instruments. Column 10 lists the company's estimate of the accuracy of the entire instrument calibration process. Column 11 provides any additional comments on the questionnaire on the calibration conditions.

Calibration Services using Alpha Particles

Line Number	Company Name	State	Calibration Source Radionuclide	Source Geometry
1	C. E. Epperson	AR	241-Am	Distributed, 1 cm circle
2	Don L. Collins & Assoc.	CA	238-U	2 in. dia
3		CA	230-Th	Various
4	Health Physics Instruments, Inc.	CA	238-U	Disc, 2 cm dia
5		CA	235-U	Disc, 2 cm dia
6		CA	241-Am	Disc, 2 cm dia
7	General Dynamics Services Company	CT	239-Pu	Distributed, 1.91 to 2.54 cm dia
8	Health Physics Assoc. Ltd.	IL	239-Pu	Disks, 2.7 cm dia
9	Stan A. Huber Consultants, Inc.	IL	241-Am	Distributed, 1 in. dia
10		IL	228-Th	Distributed, 1 in. dia
11		IL	230-Th	Distributed, 1 in. dia
12	Midwest Calibration Center	IL	230-Th	7.54 cm
13		IL	230-Th	2.54 cm
14	Radiation Safety Services, Inc.	IL	230-Th	19 mm dia
15	Standard Nuclear Consultants, Ltd.	IL	239-Pu	1 in. dia
16		IL	230-Th	0.75 in. dia
17	Midwest Radiation Protection, Inc.	IN	230-Th	Plated. 2 cm dia
18		IN	241-Am	1 cm dia
19	A. Jacobson & Assoc., Inc.	KY	230-Th	Distributed. 2 cm disk
20		KY	239-Pu	Distributed, 2.8 cm disk
21	Nuclear Instrument Co.	MA	239-Pu	1 in.dia
22	Health Physics Services, Inc.	MD	238-Pu	Point
23		MD	241-Am	Point
24	Teledyne Isotopes	NJ	239-Pu	Distributed, 2.54 cm dia
25	Eberline Instrument Corporation	NM	239-Pu	1.91, 2.54 and 4.45 cm dia
26		NM	241-Am	0.46, 1.91 and 4.45 cm dia
27		NM	230-Th	1.91 and 4.45 cm dia
28	The NDL Organization, Inc.	NY	239-Pu	Distributed, area=6.2 cm^2
29	Nuclear Consulting Services, Inc.	OH	241-Am	Distributed, 3 mm dia
30	Health Physics Northwest	OR	239-Pu	Distributed, 1 in.dia
31		OR	230-Th	Distributed, .75 in.dia
32	Applied Health Physics, Inc.	PA	239-Pu	Distributed, 3.3 cm by 3.3 cm
33		PA	239-Pu	Distributed, 1 in. dia
34	Eberline Instrument Corporation	SC	239-Pu	1.91, 2.54 and 4.45 cm dia
35		SC	241-Am	0.46, 1.91 and 4.45 cm dia
36		SC	230-Th	1.91 and 4.45 cm dia

Calibration Services using Alpha Particles

Intensity (Low)	(High)	(Units)	Calibration Method(s)	Accuracy (%)	Comments	Line Number
0.00	14.7	A/s	B	10		1
3160.00	188000.0	dpm	B,C	5	Range obtained with 5 sources	2
0.00	0.0		C	10	Various intensities	3
0.00	439.0	A/m	B	10		4
0.00	110000.0	A/m	B	15		5
0.00	32000.0	A/m	B	15		6
0.30	315.1	nCi	B	2		7
448.00	1450000.0	A/m	B	10	Into 2 pi geometry, 4 sources	8
1000.00	200000.0	dpm	A	5		9
1000.00	200000.0	dpm	A	5		10
1000.00	200000.0	dpm	A	5		11
0.00	193.0	cpm	A,B	19		12
0.00	169000.0	cpm	A,B	2		13
0.00	8.0	nCi	A	2		14
1120.00	1680000.0	cpm	B	10		15
6660.00	22200.0	cpm	B	10		16
0.00	4590.0	A/m	B	3		17
0.00	41.9	nCi	B	3		18
0.00	42570.0	dpm	B	10		19
0.00	5790.0	dpm	B	10	Alphas into 2 pi	20
20.00	25000.0	A/s	A,B	5	Range obtained with 4 sources	21
0.00	50000.0	A/s	A	10		22
0.00	83000.0	A/s	A	10		23
15.00	7500.0	A/s	B	1-16		24
180.00	6000000.0	A/m	B	2	Alphas into 2 pi	25
645.00	2600000.0	A/m	B	2	Alphas into 2 pi	26
314.00	140000.0	A/m	B	2	Alphas into 2 pi	27
28.00	18900.0	A/s	B	2	Uses 4 sources	28
0.00	5.9	nCi	A	4		29
350.00	438400.0	cpm	B	5		30
0.00	16000.0	dpm	A	2		31
1380.00	1300000.0	cpm	B	10	Uses 4 sources	32
39000.00	53600.0	dpm	B	10	Uses 2 sources, Alphas into 2 pi	33
180.00	6000000.0	A/m	B	2	Alphas into 2 pi	34
645.00	2600000.0	A/m	B	2	Alphas into 2 pi	35
314.00	140000.0	A/m	B	2	Alphas into 2 pi	36

CALIBRATION METHOD - Source known in terms of: (A) activity, (B) emission rate, (C) reference instrument, (D) other

Calibration Services using Alpha Particles

Line Number	Company Name	State	Calibration Source Radionuclide	Source Geometry
37	Atomic Energy Industrial Labs of the Southwest, Inc.	TX	239-Pu	Distributed, 5 cm by 5 cm
38	W. H. Henken Industries, Inc.	TX	230-Th	5 mm dia
39		TX	241-Am	3/16 in. dia
40	Ludlum Measurements, Inc.	TX	241-Am	Distributed, 2.54 cm dia
41		TX	230-Th	Distributed, 1.91 cm dia
42		TX	239-Pu	Distributed, 2.54 cm dia
43	Nuclear Sources & Services	TX	241-Am	5 cm x 5 cm
44		TX	239-Pu	5 cm x 5 cm
45	University of Utah, Dept. of Radiological Health	UT	239-Pu	2.5 cm dia
46	Ralph M. Baltzo	WA	241-Am	Point
47	Radiation Protection	WA	239-Pu	Distributed, 1.25 in. dia

Calibration Services using Alpha Particles

Intensity (Low)	(High)	(Units)	Calibration Method(s)	Accuracy (%)	Comments	Line Number
19.20	30400.0	A/s	B	5	Alphas into 2 pi	37
0.00	5.7	nCi		3		38
0.00	6.3	nCi		3.7		39
0.00	37500.0	A/s	B	2		40
30.60	36.0	A/s	B	3-8.4		41
27.00	17700.0	A/s	B	5		42
50.00	400.0	A/s	B	5		43
50.00	400.0	A/s	B	5		44
1100.00	1440000.0	A/m		1.5	Uses 4 sources, alphas into 2 pi	45
0.00	22200.0	A/s	A	5		46
1105.00	1046600.0	A/m	B	2	Uses 4 sources	47

CALIBRATION METHOD - Source known in terms of: (A) activity, (B) emission rate, (C) reference instrument, (D) other

BETA-PARTICLE SOURCES(1)

Source	Half-Life	Average Energy (keV)	Maximum Energy (keV)	Occurrence (%)
14-C	5730 y	49.47	156.5	100
36-Cl	3.01 E5 y	251.3	709.6	99.0
90-Y	64.0 h	934.8	2284.4	100
90-Sr	29.1 y	195.8	546.0	100
99-Tc	2.13 E5 y	84.6	293.6	99.998
106-Ru	368.2 d	10.03	39.4	100
106-Rh	29.92 s	977.	2407.	9.8
		1267.	3029.	8.2
		1509.	3541.	78.7
137-Cs	30 y	156.8	511.6	94.6
		415.2	1173.2	5.4
147-Pm	2.62 y	62.0	224.7	99.994
204-Tl	3.78 y	244.	763.	97.4
210-Pb	22.26 y	4.14	16.5	80.2
		16.13	63.0	19.8
210-Bi	5.013 d	389.0	1161.4	99.999

(1) Kocher, D. C., **Radioactive Decay Data Tables**, 1981, U. S. Department of Energy Report DOE/TIC-11026, available from National Technical Information Service

CALIBRATION SERVICES USING BETA PARTICLES

The first three columns provide the normal identification information. The next two columns list the particular beta emitting radionuclides the company has available for calibrating instruments together with information on the geometry of the particular source. The next three columns provide information on the range of intensities available for calibration together with the units used. When a lower range was specified, usually more than one source was used. The number of essentially identical sources is recorded under the "Comments" column. If no intensity range was specified, it was only recorded under the Intensity (High) column as the maximum value. In column 8, B/m represents betas/min. No attempt was made to convert dpm to activity. Using a keyed code, column 9 indicates what calibration method(s) the company used to calibrate beta measuring instruments. Column 10 lists the company's estimate of the accuracy of the entire instrument calibration process. Column 11 provides any additional comments on the questionnaire on the calibration conditions.

Calibration Services using Beta Particles

Line Number	Company Name	State	Calibration Source Radionuclide	Source Geometry
1	Perry Radiological Consulting, Inc.	AL	14-C	Not Given
2		AL	90-Sr/90-Y	Not Given
3	C. E. Epperson	AR	36-Cl	Point, no flatteners
4		AR	210-Bi	Point, no flatteners
5	Don L. Collins & Assoc.	CA	14-C	Distributed 1/2 in. dia
6		CA	36-Cl	Distributed 1/2 in. dia
7		CA	90-Sr/90-Y	Distributed 1/2 in. dia
8		CA	99-Tc	Distributed 1/2 in. dia
9		CA	210-Po	Distributed 1/2 in. dia
10		CA	137-Cs	Distributed 1/2 in. dia
11	Health Physics Instruments, Inc.	CA	14-C	Disc, 2 cm dia
12		CA	99-Tc	Disc, 2 cm dia
13		CA	90-Sr/90-Y	Disc, 2 cm dia
14		CA	36-Cl	Disc, 2 cm dia
15	General Dynamics Services Company	CT	99-Tc	Distributed, flat, 2 in. dia
16		CT	U	Distributed, flat contact
17	Radiology Association of Macon	GA	14-C	Point
18	Health Physics Assoc. Ltd.	IL	63-Ni	Point
19		IL	14-C	Point
20		IL	99-Tc	Point
21		IL	36-Cl	Point
22		IL	90-Sr/90-Y	Point
23		IL	90-Sr/90-Y	Point
24	Stan A. Huber Consultants, Inc.	IL	14-C	Distributed, 1 in. dia
25		IL	99-Tc	Distributed, 1 in. dia
26		IL	36-Cl	Distributed, 1 in. dia
27		IL	147-Pm	Distributed, 1 in. dia
28		IL	90-Sr/90-Y	Distributed, 1 in. dia
29		IL	210-Pb/210-Bi	Distributed, 1 in. dia
30	Midwest Calibration Center	IL	99-Tc	100 cm^2
31		IL	90-Sr/90-Y	100 cm^2
32	Radiation Safety Services, Inc.	IL	147-Pm	24 mm dia
33		IL	99-Tc	24 mm dia
34		IL	36-Cl	24 mm dia
35		IL	90-Sr/90-Y	24 mm dia
36		IL	14-C	24 mm dia
37	Standard Nuclear Consultants, Ltd.	IL	90-Sr/90-Y	1 in. dia
38		IL	99-Tc	0.75 in. dia
39	Midwest Radiation Protection, Inc.	IN	14-C	Point, no flatteners
40		IN	99-Tc	Plated, 2 cm dia
41		IN	99-Tc	Point, no flatteners
42		IN	36-Cl	Point, no flatteners
43		IN	210-Bi	Point, no flatteners
44	A. Jacobson & Assoc., Inc.	KY	99-Tc	Distributed, 2 cm disk
45	Nuclear Instrument Co.	MA	90-Sr/90-Y	5 mm active area

Calibration Services using Beta Particles

Intensity			Calibration	Accuracy		Line
(Low)	(High)	(Units)	Method(s)	(%)	Comments	Number
0.00	16.0	nCi	A,B,C	5		1
0.00	9.0	nCi	A,B,C	5		2
0.00	100.0	nCi	A	10		3
0.00	100.0	nCi	A	10		4
0.00	130.0	nCi	A,D	3		5
0.00	10.0	nCi	A,D	3		6
0.00	15.0	nCi	A,D	3		7
0.00	15.0	nCi	A,D	3		8
0.00	50.0	nCi	A,D	3		9
0.00	5.0	nCi	A,D	3		10
0.00	189000.0	B/m	B	15		11
0.00	68500.0	B/m	B	15		12
0.00	32000.0	B/m	B	15		13
0.00	151000.0	B/m	B	15		14
1000.00	40000.0	dpm	B	3		15
0.00	234.0	mrad/h	C	5	Natural U plaque	16
0.00	5.0	uCi	B	10		17
0.00	17500.0	B/m	A	10	Into 2 pi geometry	18
0.00	14500.0	B/m	A	10	Into 2 pi geometry	19
0.00	44400.0	B/m	A	10	Into 2 pi geometry	20
0.00	27700.0	B/m	A	10	Into 2 pi geometry	21
0.00	39700.0	B/m	A	10	Into 2 pi geometry	22
0.00	11500000000.0	B/m	A	10	Into 2 pi geometry	23
2000.00	200000.0	B/s	A	10		24
2000.00	200000.0	B/s	A	10		25
2000.00	200000.0	B/s	A	10		26
2000.00	200000.0	B/s	A	10		27
2000.00	200000.0	B/s	A	10		28
2000.00	200000.0	B/s	A	10		29
1200.00	70000.0	cpm	A,B	10		30
0.00	174000.0	dpm	A,B	10		31
0.00	124.0	nCi	A	5		32
0.00	41.0	nCi	A	5		33
0.00	23.0	nCi	A	5		34
0.00	20.0	nCi	A	6		35
0.00	161.0	nCi	A	5		36
8880.00	22200.0	dpm	B,C	10		37
6660.00	22200.0	dpm	B,C	10		38
0.00	177.0	nCi	B	5		39
0.00	11110.0	B/m	B	3		40
0.00	45.0	nCi	B	5		41
0.00	23.0	nCi	B	5		42
0.00	20.0	nCi	B	5		43
0.00	6870.0	dpm	B	20	Into 2 pi geometry	44
0.00	1300.0	dpm	A,B	3.2		45

CALIBRATION METHOD - Source known in terms of: (A) activity, (B) emission rate, (C) dose rate, (D) reference instrument, (E) other

Calibration Services using Beta Particles

Line Number	Company Name	State	Calibration Source Radionuclide	Source Geometry
46	Health Physics Services, Inc.	MD	14-C	2 pi
47		MD	129-I	Point, no flatteners
48	Johnston Laboratories	MD	14-C	N/A
49	Teledyne Isotopes	NJ	99-Tc	Distributed, 2.54 cm dia
50	Eberline Instrument Corporation	NM	99-Tc	1.91, 2.54 and 4.45 cm dia
51		NM	90-Sr/90-Y	2.54 and 4.45 cm dia
52	The NDL Organization, Inc.	NY	14-C	Distributed, area = 3.1 cm^2
53		NY	99-Tc	Distributed, area = 3.1 cm^2
54	Nuclear Consulting Services, Inc.	OH	36-Cl	Point, no flatteners
55	Health Physics Northwest	OR	99-Tc	Distributed, .75 in.dia
56	Applied Health Physics, Inc.	PA	14-C	Distributed, 1 in. dia
57		PA	90-Sr/90-Y	Distributed, 1 in. dia
58	Eberline Instrument Corporation	SC	99-Tc	1.91, 2.54 and 4.45 cm dia
59		SC	90-Sr/90-Y	2.54 and 4.45 cm dia
60	W. H. Henken Industries, Inc.	TX	99-Tc	Point source
61		TX	90-Sr/90-Y	
62	Ludlum Measurements, Inc.	TX	147-Pm	Distributed, 4 in. dia
63		TX	90-Sr/90-Y	Point, no flatteners
64		TX	99-Tc	Distributed, 2.54 cm dia
65		TX	238-U	Distributed, 4 in. slab
66	Nuclear Sources & Services	TX	90-Sr/90-Y	5 cm x 5 cm
67		TX	99-Tc	5 cm x 5 cm
68	University of Utah, Dept. of Radiological Health	UT	14-C	Multi-mount/scatterless source
69		UT	147-Pm	Multi-mount/scatterless source
70		UT	36-Cl	Multi-mount/scatterless source
71		UT	99-Tc	Multi-mount/scatterless source
72		UT	90-Sr/90-Y	Multi-mount/scatterless source
73		UT	99-Tc	Disk, 2.5 cm dia
74	Ralph M. Baltzo	WA	14-C	Point, no flatteners
75		WA	99-Tc	Point, no flatteners
76		WA	137-Cs	Point, no flatteners
77		WA	36-Cl	Point, no flatteners
78		WA	210-Bi	Point, no flatteners
79		WA	90-Sr/90-Y	Point, no flatteners
80	Battelle, Pacific Northwest Laboratory	WA	90-Sr/90-Y	Point, no flatteners
81		WA	204-Tl	Point, flatteners
82		WA	147-Pm	Point, flatteners
83		WA	14-C	20 cm x 20 cm
84		WA	U	19 cm x 13 cm
85		WA	106-Ru/106-Rh	Point, no flatteners
86	Radiation Protection	WA	90-Sr/90-Y	Distributed
87		WA	14-C	Distributed

Calibration Services using Beta Particles

Intensity			Calibration Method(s)	Accuracy (%)	Comments	Line Number
(Low)	(High)	(Units)				
0.00	340000.0	B/s	A	10		46
0.00	0.0		A	10		47
0.00	0.1	Ci/m^3	A	10		48
9.00	9000.0	B/s	B	1-20		49
120.00	383000.0	B/m	B	3	Betas into 2 pi	50
500.00	172000.0	B/m	B	3	Betas into 2 pi	51
0.00	164.0	nCi	A	6		52
0.00	41.0	nCi	A	5		53
0.00	94.9	nCi	A	5		54
0.00	23400.0	dpm	B	4		55
2156.00	161700.0	dpm	B	10	Uses 3 sources, Betas into 2 pi	56
18600.00	19200.0	dpm	B	10	Uses 2 sources, Betas into 2 pi	57
120.00	383000.0	B/m	B	3	Betas into 2 pi	58
500.00	172000.0	B/m	B	3	Betas into 2 pi	59
0.00	5.9	nCi		5		60
0.00	5.5	nCi		4		61
0.00	110.9	nCi	A	5.1		62
0.00	60.3	B/s	B	5		63
1.80	3700.0	B/s	B	3-16		64
0.00	234.0	mrad/h	C	19	Depleted U source	65
77.00	1100.0	B/s	B	5		66
60.00	1600.0	B/s	B	5		67
0.00	161.0	nCi	B	6		68
0.00	110.9	nCi	B	6		69
0.00	23.0	nCi	B	6		70
0.00	41.0	nCi	B	6		71
0.00	20.5	nCi	B	6		72
285.00	313400.0	cpm	B	3	Uses 4 sources, betas into 2 pi	73
0.00	800.0	B/s	A	10		74
0.00	1500.0	B/s	A	10		75
0.00	1100.0	B/s	A	6		76
0.00	850.0	B/s	A	10		77
0.00	750.0	B/s	A	15		78
220.00	560.0	B/s	A	5		79
600.00	195000.0	mrad/h	C	4		80
0.00	43.0	mrad/h	C	5		81
0.00	5.0	mrad/h	C	5		82
0.00	1.4	mrad/h	C	5		83
0.00	230.0	mrad/h	C	4		84
0.00	50.0	mrad/h	C	4		85
0.00	20.7	nCi	A	5.6		86
0.00	161.0	nCi	A	5		87

CALIBRATION METHOD - Source known in terms of: (A) activity, (B) emission rate, (C) dose rate, (D) reference instrument, (E) other

GAMMA-RAY SOURCES(1)

Source	Half-Life	Energy(2) (keV)	Occurrence(2) (%)
57-Co	271 d	14.4	9.5
		122.1	85.5
		136.4	10.6
60-Co	5.271 y	1173.2	100
		1332.4	100
109-Cd	464 d	22.0	28.5
		22.2	54.0
		24.9	17.4
133-Ba	10.5 y	30.6	34.2
		31.0	63.4
		35.0	22.8
		81.0	33.0
		276.4	6.9
		302.8	17.8
		356.0	60
		383.8	8.7
137-Cs	30 y	661.6	85.0
226-Ra	1600 y	10.8	37.1
		74.8	6.2
		77.1	10.5
		242.0	7.5
		295.2	19.2
		351.9	37.2
		609.3	46.3
		1120.3	15.1
		1238.0	5.9
		1764.5	15.8
241-Am	432 y	59.5	35.9

(1) Kocher, D. C., **Radioactive Decay Data Tables**, 1981, U. S. Department of Energy Report DOE/TIC-11026, available from National Technical Information Service.

(2) Only gamma-rays with energy greater than 10 keV and which occur more than 5% of the time are listed.

CALIBRATION SERVICES USING GAMMA RAYS

The first three columns provide the normal identification information. The next column lists the particular gamma emitting radionuclides the company has available for calibrating instruments. The next three columns provide information on the range of intensities available for calibration together with the units used. When a lower range was specified, usually more than one source was used. The number of essentially identical sources is recorded under the "Comments" column. If no intensity range was specified, it was only recorded under the Intensity (High) column as the maximum value. In column 7 no attempt was made to convert dps to exposure rate. Using a keyed code, column 8 indicates what calibration method(s) the company used to calibrate gamma measuring instruments. Column 9 lists the company's estimate of the accuracy of the entire instrument calibration process. Those companies accredited by the CRCPD for calibrating gamma survey instruments are explicitly identified.

Calibration Services using Gamma Rays

Line Number	Company Name	State	Radionuclide	Intensity (Low)	(High)	(Units)
1	Don Hamner	AL	137-Cs	0.50	2000.0	mR/h
2	Perry Radiological Consulting, Inc.	AL	137 Cs	0.10	100000.0	mR/h
3	H. Thomas Bennett	AR	137-Cs	0.05	5000.0	mR/h
4		AR	60-Co	1.00	200000.0	mR/h
5	C. E. Epperson	AR	137-Cs	1.00	2000.0	mR/h
6		AR	60-Co	1.00	100.0	mR/h
7	Murray Lures	AR	137-Cs	1.00	100000.0	mR/h
8	South Arkansas Radiation Therapy Institute	AR	137-Cs	1.00	1000.0	mR/h
9	Radiation Safety Engineering, Inc.	AZ	137-Cs	0.10	1500.0	mR/h
10	Radiological Physics Services, Inc.	AZ	226-Ra	0.50	1000.0	mR/h
11	Don L. Collins & Assoc.	CA	60-Co	0.01	100.0	mR/h
12		CA	137-Cs	0.10	2000.0	mR/h
13		CA	226-Ra	0.10	2000.0	mR/h
14		CA	109-Cd	0.00	0.5	mR/h
15	Health Physics Instruments, Inc.	CA	226-Ra	0.01	100.0	mR/h
16		CA	60-Co	0.01	500000.0	mR/h
17	Office of Emergency Services	CA	137-Cs	2.00	100000.0	mR/h
18	Radcal Corp	CA	60-Co	1000.00	12000000.0	mR/h
19		CA	137-Cs	50.00	90000.0	mR/h
20	SIMCO Electronics	CA	60-Co	0.10	1200.0	mR/h
21	Geoffrey S. Ibbott	CO	137-Cs	0.50	1000.0	mR/h
22	mR Services, Inc.	CO	137-Cs	0.20	1000.0	mR/h
23	St. Mary's Hospital and Medical Center	CO	137-Cs	1.00	300.0	mR/h
24	General Dynamics Services Company	CT	137-Cs	0.30	500000.0	mR/h
25		CT	60-Co	0.10	3000.0	mR/h
26	Radiation Consulting Associates, Inc.	FL	137-Cs	0.05	2000.0	mR/h
27	Sun Nuclear Corporation	FL	137-Cs	0.05	50.0	mR/h
28		FL	137-Cs	50.00	8000.0	mR/h
29	Radiology Assoc. of Macon	GA	137-Cs	1.00	1000.0	mR/h
30	Morrison-Knudsen Co., Inc.	ID	137-Cs	0.10	10000.0	mR/h
31	Conam Inspection	IL	137-Cs	0.00	300.0	mCi
32	Health Physics Assoc. Ltd.	IL	137-Cs	0.40	4000.0	mR/h
33		IL	137-Cs	0.10	2.0	mR/h
34		IL	241-Am	0.10	10.0	mR/h
35		IL	60-Co	0.20	20.0	mR/h
36		IL	57-Co	0.10	8.0	mR/h
37	Stan A. Huber Consultants, Inc.	IL	57-Co	0.10	1000.0	mR/h
38		IL	60-Co	0.10	10000.0	mR/h
39		IL	137-Cs	0.10	10000.0	mR/h
40	Midwest Calibration Center	IL	137-Cs	0.07	295000.0	mR/h
41		IL	60-Co	0.01	4760000.0	mR/h
42	Radiation Instrument Calibration Laboratory	IL	137-Cs	0.50	3000.0	mR/h
43	Radiation Safety Services, Inc.	IL	137-Cs	0.10	100000.0	mR/h
44	Standard Nuclear Consultants, Ltd.	IL	57-Co	0.05	1000.0	mR/h
45		IL	60-Co	0.05	10000.0	mR/h
46		IL	137-Cs	0.05	10000.0	mR/h

Calibration Services using Gamma Rays

Calibration Method(s)	Accuracy (%)	Comments	Line Number
B	10		1
A,B,C	10		2
B	10		3
B	10		4
B	15		5
D	15		6
B	3-5		7
B	3-5		8
A,B	7		9
B	10		10
A,B	4-10		11
A,B	5-10		12
A,B	5-10		13
A,B	10	Special geo. for TVX-1 X-xay inst.	14
B	10	Range obtained with 2 sources	15
B	10	Range obtained with 5 sources	16
A,B	10		17
A	5		18
A	5		19
B	5		20
B	10		21
B	15		22
B	10		23
A,B	4		24
A,B	2		25
D	4		26
A,B	8		27
A,B	5		28
C	10		29
B,C	5		30
B	20		31
A	10	Range obtained with 2 sources	32
C	10		33
C	10		34
C	10		35
C	10		36
A,B,C	5		37
A,B,C	5		38
A,B,C	5		39
C	5		40
C	5		41
A,B	10	Range obtained with 2 sources, accredited by CRCPD	42
B,C	3		43
A,B,C	5		44
A,B,C	5		45
A,B,C,D	5		46

CALIBRATION METHOD - Field known in terms of: (A) Response of reference instrument, (B) Source calibrated for exposure rate at fixed distance, (C) Source calibrated for activity, (D) Source calibrated for emission rate, (E) other

Calibration Services using Gamma Rays

Line Number	Company Name	State	Radionuclide	Intensity (Low)	(High)	(Units)
47	Midwest Radiation Protection, Inc.	IN	137-Cs	0.00	4700.0	mR/h@1m
48		IN	137-Cs	0.00	47.0	mR/h@1m
49		IN	137-Cs	0.00	24.0	mR/h@1m
50	Chris M. Hearn	KS	137-Cs	0.05	1000.0	mR/h
51	Radiation Consultants of Mid-America, Inc.	KS	137-Cs	0.10	2000.0	mR/h
52	A. Jacobson & Assoc., Inc.	KY	137-Cs	0.40	300.0	mR/h
53		KY	226-Ra	2.00	33.0	mR/h
54	Professional Radiation Services Corp.	KY	226-Ra	0.00	0.0	
55		KY	60-Co	0.00	0.0	
56	Industrial Radiography Maintenance & Supply Co., Inc.	LA	137-Cs	0.00	1000.0	mR/h
57	Source Production and Equipment Co., Inc.	LA	137-Cs	1.00	1000.0	mR/h
58	Amersham	MA	137-Cs	1.00	10000.0	mR/h
59	Baird Corporation	MA	60-Co	1.00	200.0	mR/h
60	Nuclear Instrument Co.	MA	137-Cs	0.02	400000.0	mR/h
61		MA	226-Ra	0.05	2000.0	mR/h
62	Health Physics Services, Inc.	MD	137-Cs	0.15	1600.0	mR/h
63		MD	137-Cs	0.00	7780.0	mR/h@1m
64		MD	133-Ba	0.00	195.0	mR/h
65	Mid-Atlantic Radiation Physics, Inc.	MD	137-Cs	0.10	2450.0	mR/h
66	Neutron Products, Inc.	MD	60-Co	0.00	0.0	
67	Conam Inspection	MN	137-Cs	0.00	300.0	mCi
68	R. M. Wester & Associates, Inc.	MO	137-Cs	0.00	2000.0	mR/h
69	Ionizing Radiation Services	MS	137-Cs	0.01	200000.0	mR/h
70		MS	60-Co	0.01	1.0	mR/h
71	Jerry O. Morris	MS	137-Cs	0.50	100.0	mR/h
72		MS	60-Co	50.00	200.0	R/min
73	Calib-Ray, Ltd.	NC	137-Cs	0.10	5000.0	mR/h
74	Bio Med Associates, Inc.	NJ	137-Cs	0.10	1000.0	mR/h
75		NJ	60-Co	30.00	120.0	R/min
76	Teledyne Isotopes	NJ	137-Cs	0.10	1000.0	mR/h
77	Eberline Instrument Corporation	NM	137-Cs	0.03	1000000.0	mR/h
78		NM	60-Co	0.03	10000.0	mR/h
79		NM	133-Ba	0.07	2.0	uCi
80	Syncor Instrument Corp.	NM	137-Cs	0.10	1000000.0	mR/h
81	Certified Testing Laboratories, Inc.	NY	137-Cs	0.10	2000.0	mR/h
82	Medi-Ray Inc.	NY	137-Cs	0.10	800.0	mR/h
83	The NDL Organization, Inc.	NY	137-Cs	1.00	3000.0	mR/h
84	Bicron Corporation	OH	137-Cs	0.50	10000.0	mR/h
85	Conam Inspection	OH	137-Cs	0.00	300.0	mCi
86	Dosimeter Corporation	OH	137-Cs	0.25	10000.0	mR/h
87		OH	60-Co	2700.00	1000000.0	mR/h
88	NMA-Medical Physics Services	OH	226-Ra	0.04	1400.0	mR/h
89		OH	57-Co	1.00	4.5	mR/h
90		OH	137-Cs	0.04	1400.0	mR/h
91	Nuclear Consulting Services, Inc.	OH	60-Co	0.00	15.9	mCi
92	Reuter-Stokes	OH	60-Co	0.02	10000.0	mR/h

Calibration Services using Gamma Rays

Calibration Method(s)	Accuracy (%)	Comments	Line Number
B	5		47
B	3	Uses absorbers	48
B	6		49
C	7	Range obtained with 2 sources	50
B	5		51
B	10		52
B	10		53
C	10-20		54
C	10-20		55
B	10		56
A,B,C,D,E	10		57
A	5		58
B,C	5		59
B,D	5	Range obtained with 2 sources	60
B	10	Range obtained with 2 sources	61
B	5		62
A	10		63
B	10		64
B	10		65
		Megacuries of 60-Co	66
B	20		67
B,C,D,E	5		68
B	5	Low intensity calibrations down to 5 uR/h	69
C	5		70
B	5		71
B	5		72
B	10		73
B	5		74
B	5		75
A	2	Uses 2 sources	76
A	3		77
A	5		78
D	10		79
B	5	Uses 2 sources	80
B	10		81
B	10		82
B	8		83
A,B	10		84
B	20		85
	5		86
B	1	Uses 2 sources	87
B	8.2	Uses 2 sources	88
A,B	10		89
B	8.2		90
C	8		91
B	15		92

CALIBRATION METHOD - Field known in terms of: (A) Response of reference instrument, (B) Source calibrated for exposure rate at fixed distance, (C) Source calibrated for activity, (D) Source calibrated for emission rate, (E) other

Calibration Services using Gamma Rays

Line Number	Company Name	State	Radionuclide	Intensity		
				(Low)	(High)	(Units)
93	Schneider & Wuest, Inc.	OH	137-Cs	0.10	500.0	mR/h
94		OH	60-Co	0.10	100.0	mR/h
95	Health Physics Northwest	OR	137-Cs	0.03	2500.0	mR/h
96	Applied Health Physics, Inc.	PA	137-Cs	1.00	2500.0	mR/h
97		PA	226-Ra	0.10	1000.0	mR/h
98	Capintec Instruments, Inc.	PA	60-Co	0.00	80.0	R/min
99	Conam Inspection	PA	137-Cs	0.00	300.0	mCi
100	Eberline Instrument Corporation	SC	137-Cs	0.03	1000000.0	mR/h
101	Newco Inc.	SC	137-Cs	1.00	2000.0	mR/h
102	Radiological Calibration Services, Inc.	SC	137-Cs	1.00	4000.0	mR/h
103	E. Lewis Cook & Associates, Inc.	TN	60-Co	5.00	1000.0	mR/h
104	K & S Associates, Inc.	TN	137-Cs	0.01	200.0	mR/h
105		TN	137-Cs	35.00	8000.0	mR/h
106		TN	60-Co	0.00	50.0	R/min
107	Robert Wilson	TN	137-Cs	0.50	1000.0	mR/h
108	Amersham	TX	137-Cs	1.00	10000.0	mR/h
109	Atomic Energy Industrial Labs of the Southwest, Inc.	TX	137-Cs	0.10	2000.0	mR/h
110		TX	226-Ra	0.10	500.0	mR/h
111	Conam Inspection	TX	137-Cs	0.00	300.0	mCi
112	John F. Domatti, Inc.	TX	137-Cs	0.50	2000.0	mR/h
113	GNI, Inc.	TX	137-Cs	0.04	1600.0	mR/h
114	W. H. Henken Industries, Inc.	TX	137-Cs	1.00	50000.0	mR/h
115	Kenzac Communications Service	TX	137-Cs	1.00	1000.0	mR/h
116	Ludlum Measurements, Inc.	TX	241-Am	5.50	84.6	mCi
117		TX	133-Ba	0.00	288.0	mCi
118		TX	109-Cd	0.00	7.3	mCi
119		TX	57-Co	5.10	101.9	mCi
120		TX	60-Co	0.12	51.0	mCi
121		TX	137-Cs	0.83	201.0	mCi
122		TX	137-Cs	1.00	500000.0	mR/h
123		TX	129-I	0.00	1040.0	mCi
124	Medical & Radiation Physics, Inc.	TX	137-Cs	0.10	1000.0	mR/h
125	Nuclear Sources & Services	TX	137-Cs	0.10	100000.0	mR/h
126		TX	60-Co	0.10	100000.0	mR/h
127		TX	226-Ra	0.10	1000.0	mR/h
128	R/A Services	TX	137-Cs	0.10	2000.0	mR/h
129	Radiation Consultants, Inc.	TX	137-Cs	1.00	1500.0	mR/h
130		TX	137-Cs	1.00	1000.0	mR/h
131	G. E. Smith & Associates, Inc.	TX	137-Cs	1.00	2000.0	mR/h
132		TX	137-Cs	1.00	1000.0	mR/h
133	University of Utah, Dept. of Radiological Health	UT	137-Cs	0.50	20000.0	mR/h
134	Physics Associates	VA	137-Cs	0.10	1500.0	mR/h

Calibration Services using Gamma Rays

Calibration Method(s)	Accuracy (%)	Comments	Line Number
C	3		93
C	5		94
C	10	Uses 2 sources	95
B	10		96
B	10		97
A	2		98
B	20		99
A,E	3		100
B	20		101
B	15		102
B	10		103
A	10	Uses 2 sources	104
A,E	0.5	Calibrated beam monitor, uses two sources	105
A,E	0.5	Calibrated beam monitor	106
B	10		107
A	5		108
B,C	10		109
B,C	10		110
B	20		111
A,B	20		112
B	10		113
B	10	Uses 2 sources	114
B	10		115
D	3.4-3.7		116
C	3.7		117
A	5.1		118
A,D	3.5-3.9		119
C	3.9-7.0		120
D	4-5		121
B	5		122
C	3.3		123
B	15		124
B	5		125
B	5		126
B	5		127
A,B	15		128
E	10		129
A	10		130
A,B	10		131
A	10		132
A,B	5	Small chambers max is 100 R/h	133
B	10		134

CALIBRATION METHOD - Field known in terms of: (A) Response of reference instrument, (B) Source calibrated for exposure rate at fixed distance, (C) Source calibrated for activity, (D) Source calibrated for emission rate, (E) other

Calibration Services using Gamma Rays

Line Number	Company Name	State	Radionuclide	Intensity (Low)	(High)	(Units)
135	Ralph M. Baltzo	WA	137-Cs	100.00	800.0	mR/h
136		WA	137-Cs	0.00	8.0	mR/h
137		WA	137-Cs	0.00	20000.0	dps
138		WA	57-Co	0.00	1200.0	dps
139		WA	57-Co	0.00	2.0	mR/h
140		WA	133-Ba	0.00	0.5	mR/h
141		WA	129-I	200.00	18000.0	dps
142	Battelle, Pacific Northwest Laboratory	WA	137-Cs	2.00	450000.0	mR/h
143		WA	60-Co	40.00	1000000000.0	mR/h
144	INDELCO, INC.	WA	137-Cs	2.00	1000.0	mR/h
145	Radiation Protection	WA	137-Cs	0.10	500000.0	mR/h
146		WA	226-Ra	1.00	1000.0	mR/h
147	University of Washington	WA	137-Cs	1.00	3500.0	mR/h

Calibration Services using Gamma Rays

Calibration Method(s)	Accuracy (%)	Comments	Line Number
A	9	Uses 2 sources	135
A	10		136
C	6		137
C	12		138
C	6		139
C	15		140
C	6	Uses 3 sources	141
A,B	4		142
A,B	4		143
B	5		144
B	5		145
B	10		146
A	10	Uses 2 sources, accredited by CRCPD	147

CALIBRATION METHOD - Field known in terms of: (A) Response of reference instrument, (B) Source calibrated for exposure rate at fixed distance, (C) Source calibrated for activity, (D) Source calibrated for emission rate, (E) other

NEUTRON SOURCES

Source	Half-Life (years)	Spectrum Type
238-PuBe	87.8	Be(α,n)
239-PuBe	2.41E4	Be(α,n)
241-AmBe	432	Be(α,n)
241-AmLi	432	Li(α,n)
252-Cf	2.64	Spontaneous fission
252-Cf(moderated)	2.64	Spontaneous fission,D2O moderated

CALIBRATION SERVICES USING NEUTRONS

The first three columns provide the normal identification information. The next column lists the radionuclide sources the company has available for calibrating instruments. The next three columns provide information on the range of intensities available for calibration together with the units used. When a lower range was specified, usually more than one source was used. The number of essentially identical sources is recorded in the "Comments" column. If no intensity range was specified, it was only recorded under the Intensity (High) column as the maximum value. When only one source is used, it is recorded under the Intensity (High) column. Columns 8 and 9 provide information on how much time the company is willing to allot to calibrate a particular instrument, given in seconds. In column 9 "Cont." means continuously and implies that there is no upper limit on the amount of time the company will allot. Using a keyed code, column 10 indicates what calibration method(s) the company uses to calibrate neutron measuring instruments. Column 11 lists the company's estimate of the accuracy of the entire instrument calibration process. Column 12 provides any additional comments on the questionnaire on the calibration conditions.

Calibration Services using Neutrons

Line Number	Company Name	State	Radionuclide	Intensity (Low)	(High)	(Units)
1	University of Arkansas	AR	252-Cf	0.00	20000.0	mrem/h
2		AR	252-Cf	0.00	20000.0	mrem/h
3	Health Physics Instruments, Inc.	CA	PuBe	2.00	1000.0	mrem/h
4	General Dynamics Services Company	CT	238-PuBe	5.00	100.0	mrem/h
5		CT	241-AmBe	0.50	5.0	mrem/h
6	Stan A. Huber Consultants, Inc.	IL	PuBe	1.00	400.0	mrem/h
7		IL	252-Cf	1.00	1000.0	mrem/h
8	Midwest Calibration Center	IL	238-PuBe	0.00	383000.0	n/cm^2/s
9	Radiation Safety Services, Inc.	IL	252-Cf	0.00	360.0	mrem/h
10	Eberline Instrument Corporation	NM	239-PuBe	0.40	250.0	mrem/h
11	Eberline Instrument Corporation	SC	239-PuBe	2.00	250.0	mrem/h
12	Ludlum Measurements, Inc.	TX	241-AmBe	0.00	500.0	mrem/h
13	Nuclear Sources & Services	TX	241-AmBe	2.00	1500.0	mrem/h
14		TX	241-AmLi	2.00	1500.0	mrem/h
15		TX	252-Cf	2.00	1000.0	mrem/h
16	Battelle, Pacific Northwest Laboratory	WA	252-Cf	40.00	5000.0	mrem/h
17		WA	252-Cf	10.00	1200.0	mrem/h
18	Radiation Protection	WA	239-PuBe	5.40	27.0	mrem/h @ 3 ft

Calibration Services using Neutrons

Minimum Exposure Time (sec.)	Maximum Exposure Time (sec.)	Calibration Method(s)	Accuracy (%)	Comments	Line Number
300	Cont.	B	5		1
300	Cont.	B	10	D2O moderated	2
60	Cont.	D	10		3
		B	3		4
		B	5.5		5
	Cont.	D	8		6
	Cont.	B	8		7
60	Cont.	B	4		8
60	Cont.	B	5		9
60	Cont.	A	5	Moderated source	10
60	Cont.	A	5	Moderated source	11
	Cont.	D	5		12
		B	5	Uses 2 sources	13
		B	5		14
	200	B	5		15
60	days	B,D	5		16
60	days	B,D	5	D2O moderated	17
300	28800	D	5	Uses 2 sources	18

CALIBRATION METHOD - Field known in terms of: (A) Response of reference instrument, (B) Source calibrated for exposure rate at fixed distance, (C) Source calibrated for activity, (D) Source calibrated for emission rate, (E) other

NBS X-RAY BEAM TECHNIQUES(1)

Beam Code	Half-Value Layer Al (mm)	Half-Value Layer Cu (mm)	Homogeneity Coefficient Al	Homogeneity Coefficient Cu	Effective Energy (keV)
L10	0.029		79		
L15	0.05		74		
L20	0.071		76		
L30	0.22		60		
L40	0.49		57		
L50	0.75		58		
L80	1.83		58		
L100	2.8		59		
M20	0.152		79		
M30	0.36		64		
M40	0.73		66		
M50	1.02	0.032	66	62	
M60	1.68	0.052	68	64	
M100	5.0	0.2	72	55	
M150	10.2	0.67	87	62	
M200	14.9	1.69	95	69	
M250	18.5	3.2	98	86	
M300	22.0	5.3	100	97	
H10	0.048		89		
H15	0.152		87		
H20	0.36		88		
H30	1.23	0.038	93	94	
H40	2.9	0.093	94	95	
H50	4.2	0.142	92	90	38
H60	6.0	0.24	94	89	46
H100	13.5	1.14	100	94	80
H150	17.0	2.5	100	95	120
H200	19.8	4.1	100	99	166
H250	22.0	5.2	100	98	211
H300	23.0	6.2	99	98	252
S75	1.86		63		
S60	2.8	0.089	75	70	

(1) NBS Calibration Services Users Guide 1986-1988, NBS Special Publication 250 (1986)

The first three columns provide the normal identification information. The next column lists the peak voltage of the x-ray unit the company has available for calibrating instruments. No distinction has been made between bremsstrahlung beams and characteristic x-rays, so machines producing high-energy bremsstrahlung are also included. Some information on the range of energies available is provided in the next three columns. This is usually given in terms of thickness of material of the HVL for the beam, but for fluorescent x-rays the actual fluorescent energy is given. The next three columns provide information on the range of intensities available for calibration together with the units used. If no intensity range was specified, it was only recorded under the Intensity (High) column as the maximum value. Note that both mR/h and R/min are listed. Since many x-ray machines cannot run continuously, the limits on the amount of time available for exposing instruments is given in seconds. In column 12 "Cont." means continuously and implies that there is no upper limit on the amount of time the company will allot to calibrating a particular instrument. Using a keyed code, column 13 indicates what calibration method(s) the company uses to calibrate x-ray measuring instruments. Column 14 lists the company's estimate of the accuracy of the entire instrument calibration process. Column 15 provides any additional comments on the questionnaire on the calibration conditions. Those companies accredited by the CRCPD for calibrating x-ray survey instruments are explicitly identified.

The preceding page lists the NBS x-ray beam techniques. The beam code consists of a letter code followed by the peak kilovoltage. The letter code represents the amount of additional filtration: L = lightly filtered, M = moderately filtered, H = heavily filtered, and S = special filtration. The homogeneity coefficient is 100 times the ratio of the first HVL to the second HVL. The effective energy is computed from good-geometry copper (or aluminum) attenuation data. The initial slope of the attenuation curve is used to determine an attenuation coefficient, and the photon energy associated with this coefficient is the "effective energy".

Calibration Services using X rays

Line Number	Company Name	State	X-ray Machine	Energy		Units	
				(Low)	(High)		(Low)
1	Perry Radiological Consulting, Inc.	AL	150-kVp	0.10	10.00	mm Al	10.00
2	Health Physics Instruments, Inc.	CA	200-kVp	20.00	180.00	keV eff.	500.00
3	Office of Emergency Services	CA	150-kVp	0.35	5.00	mm Al	20000.00
4	Radcal Corp	CA	250-kVp	0.07	22.00	mm Al	0.00
5	Geoffrey S. Ibbott	CO	4-MV	0.00	0.00		1.00
6		CO	10-MV	0.00	0.00		1.00
7	Radiology Assoc. of Macon	GA	220-kVp	0.00	2.00	mm Cu	10.00
8		GA	6,9,12,15 MeV	0.00	0.00		10.00
9	Stan A. Huber Consultants, Inc.	IL	60-kVp	0.15	3.00	mm Al	0.10
10		IL	150-kVp	0.15	10.00	mm Al	0.10
11	Radiation Instrument Calibration Laboratory	IL	150-kVp	0.00	0.00		20000.00
12	Radiation Safety Services, Inc.	IL	100-kVp	0.50	2.50	mm Al	1.00
13	Chris M. Hearn	KS	50-kVp	0.30	2.00	mm Al	20000.00
14		KS	250-kVp	2.00	3.00	mm Al	50.00
15	A. Jacobson & Assoc., Inc.	KY	100-kVp	0.68	5.00	mm Al	200.00
16	Dosimeter Corporation	OH	250-kVp	0.00	0.00		2700.00
17	Keithley Instruments, Inc.	OH	100-kVp	0.00	2.70	mm Al	0.00
18	Capintec Instruments, Inc.	PA	300-kVp	1.00	18.00	mm Al	12000.00
19	Conam Inspection	TX	160-kVp	0.25	0.50	in. Cu	0.00
20	W. H. Henken Industries, Inc.	TX	150-kVp	0.10	5.00	mm Al	1.00
21	Battelle, Pacific Northwest Laboratory	WA	320-kVp	32.00	210.00	keV eff.	1.00
22		WA	160-kVp	9.00	36.00	keV eff.	26.00
23		WA	320-kVp	0.00	8.00	keV	0.00
24		WA	320-kVp	0.00	16.00	keV	0.00
25		WA	320-kVp	0.00	24.00	keV	0.00
26		WA	320-kVp	0.00	43.00	keV	0.00
27		WA	320-kVp	0.00	58.00	keV	0.00
28		WA	320-kVp	0.00	78.00	keV	0.00
29		WA	320-kVp	0.00	100.00	keV	0.00

Calibration Services using X rays

Intensity (High)	(Units)	Minimum Exposure Time (sec.)	Maximum Exposure Time (sec.)	Calibration Method(s)	Accuracy (%)	Comments	Line Number
1000000.0	mR/h	1	Cont.	A,B,C	10		1
20000.0	mR/h	10	Cont.	A	20	Heavily-Filtered beams	2
200000.0	mR/h	1	300	A	7	NBS Techniques M30,M50,L80,L100,M100	3
10.0	R/min.	0	1200	A	5	NBS Techniques: 7 "H", 9 "M", and 2 "L" series	4
1000.0	R/min.	1	Cont.	A	5		5
1000.0	R/min.	1	Cont.	A	5		6
3000000.0	mR/h	1	Cont.	A	10		7
50000000.0	mR/h	1	Cont.	A	10		8
1000.0	mR/h	0.1	120	A	10		9
10000.0	mR/h	0.1	1200	A	10		10
200000.0	mR/h	1	300	A	7	NBS Techniques M30,M50,L80,L100,M100; accredited by CRCPD	11
1000000.0	mR/h	1/60	5	A	10		12
1500000.0	mR/h	1/60	6	A	7		13
6000000.0	mR/h	1	Cont.	A	5		14
2000.0	mR/h	1	Cont.	A	10		15
20000.0	mR/h	5	Cont.	A	5	NBS Techniques H50,H150,H200,H250,(HFE-old code)	16
18000.0	mR/h	5	Cont.	A	5		17
180000.0	mR/h	10	Cont.	A	5		18
0.0		1	Cont.	A	10		19
1000000.0	mR/h	30	Cont.	A	10	25-150 kVp	20
5000.0	mR/min.		Cont.	A,B,C	5	NBS Techniques S60,H50,M100,M150,H150,M250,H200,H250	21
5500.0	mR/min.		Cont.	A,B,C	5	NBS Techniques L20,M30,M50,S75	22
20.0	mR/min.	60	Cont.	A,B,C	5	k-fluorescent x-rays	23
100.0	mR/min.	60	Cont.	A,B,C	5	k-fluorescent x-rays	24
100.0	mR/min.	60	Cont.	A,B,C	5	k-fluorescent x-rays	25
5.0	mR/min.	60	Cont.	A,B,C	5	k-fluorescent x-rays	26
20.0	mR/min.	60	Cont.	A,B,C	5	k-fluorescent x-rays	27
20.0	mR/min.	60	Cont.	A,B,C	5	k-fluorescent x-rays	28
10.0	mR/min.	60	Cont.	A,B,C	5	k-fluorescent x-rays	29

CALIBRATION METHOD - Field known in terms of: (A) Response of reference instrument, (B) Machine parameters (kV and mA)
(C) Calibrated beam monitor, (D) other

Company Identification Information

Line Number	Company Name	Company Name (cont.)	Address
1	Amersham Corp.		1408 East N. Belt Drive, Suite 130
2	Amersham Corp.		40 North Avenue
3	Applied Health Physics, Inc.		2986 Industrial Blvd., P.O. Box 197
4	University of Arkansas	Southwest Radiation Calibration Center	Eng. Exp. Station, West 20th St.
5	Atomic Energy Industrial Lab of the Southwest,Inc.		6421 South Main Street
6	Baird Corporation		125 Middlesex Turnpike
7	Ralph M. Baltzo		3841 N.E. 87th Street
8	Battelle, Pacific Northwest Laboratory		P.O. Box 999, Battelle Blvd.
9	H. Thomas Bennett	Radiation Safety Officer, UAMS	4301 West Markham
10	Bicron Corporation		12345 Kinsman Road
11	Bio Med Associates, Inc.		4 Main Street
12	Calib-Ray, Ltd.		Route 12, Box 8A
13	Capintec Instruments, Inc.		540 Alpha Drive
14	Certified Testing Laboratories, Inc.		2623 Roberts Avenue
15	Don L. Collins & Associates		418 North Glendale Ave.
16	Conam Inspection		1245 West Norwood
17	Conam Inspection		1925 Oakcrest Avenue, Suite 11
18	Conam Inspection		4000 Lockbourne
19	Conam Inspection		870 Ashland Avenue
20	Conam Inspection		6106 Rookin Street
21	E. Lewis Cook & Associates, Inc.		1800 R Dayton Blvd.
22	John F. Domatti, Inc.		P.O. Box 600
23	Dosimeter Corporation		11286 Grooms Road
24	Eberline Instrument Corporation		P.O. Box 2108, Airport Road
25	Eberline Instrument Corporation	Southeastern Facility	312 Miami Street
26	C. E. Epperson	UAMS, Slot 522	4301 West Markham
27	General Dynamics Services Company	Reactor Plant Services	P.O. Box 1147, 285 Eastern Point Road
28	GNI Incorporated		100 E. NASA Road One, Suite 411
29	Don Hamner		5824 Old Leeds Road
30	Chris M. Hearn		6027 East Gilbert
31	Health Physics Assoc., Ltd.		3304 Commercial
32	Health Physics Instruments, Inc.		124 Santa Felicia Drive
33	Health Physics Northwest		11535 SW 67 th
34	Health Physics Services, Inc.		4 Research Place, Suite 140
35	W. H. Henken Industries, Inc.		415 Lillard Road
36	Stan A. Huber Consultants, Inc.		200 North Cedar Road
37	Geoffrey S. Ibbott		90 Croft Court
38	INDELCO, INC.		115 Belmont Avenue East
39	Industrial Radiography Maintenance & Supply Co,Inc.		P.O. Box 119 (144 Beadle Street)
40	Ionizing Radiation Services		2207 Lee Loop
41	A. Jacobson & Associates, Inc.		902 Burning Springs Circle
42	Johnston Laboratories		383 Hillen Road
43	K & S Associates, Inc.		1854 Airlane Drive
44	Keithley Instruments, Inc.		28775 Aurora Road
45	Kenzac Communications Service		P.O. Box 66251
46	Ludlum Measurements, Inc.		501 Oak Street

Company Identification Information

City	State	Zipcode	Phone	Ext.	Contact	Line Number
Houston	TX	77032	(713) 449-7117		John B. McClellan, Jr.	1
Burlington	MA	01803	(617) 272-2000	x430	Susan Wheeler	2
Bethel Park	PA	15102	(412) 563-2242		John Douglas	3
Fayetteville	AR	72701	(501) 575-3440		Leon West/Tim Welty	4
Houston	TX	77030	(713) 790-9719		Steven H. Allen	5
Bedford	MA	01730	(617) 276-6502		Nuclear Service Dept.	6
Seattle	WA	98115	( ) 525-6499		Ralph M. Baltzo	7
Richland	WA	99352	(509) 376-8465		Joseph C. McDonald	8
Little Rock	AR	72205-7199	(501) 661-5299		H. Thomas Bennett	9
Newbury	OH	44065	(216) 564-2251		R. L. Wrobel	10
Flemington	NJ	08822	(201) 788-9440		Jack J. Merkin	11
Chapel Hill	NC	27514	(919) 967-5163		Conrad Knight/Dave Jorgensen	12
Pittsburgh	PA	15238	(412) 963-1988		Mahendra Patel	13
Bronx	NY	10461	(212) 824-1798		R. Plumstead	14
Glendale	CA	91206-3397	(213) 245-2711		Don L. Collins	15
Itasca	IL	60143-1186	(312) 773-9400		Ray Momsen	16
Roseville	MN	55113	(612) 636-5040		Norbert Jaroch	17
Columbus	OH	43207-4298	(614) 491-3000		James Kelker	18
Folcroft	PA	19032	(215) 237-1500		George Mayberry	19
Houston	TX	77074-3792	(713) 774-9657		Daniel Kuhn	20
Chattanooga	TN	37415	(615) 875-4430		E. Lewis Cook/J. M. DeLay	21
Simonton	TX	77476	(713) 346-1674		John F. Domatti	22
Cincinnati	OH	45242	(513) 489-8100		Al Zirkes	23
Santa Fe	NM	87504-2108	(505) 471-3232		Joe Suazo	24
West Columbia	SC	29169	(803) 796-3604		John Witzell	25
Little Rock	AR	72205	(501) 661-6280		C.E. Epperson	26
Groton	CT	06340	(203) 446-4300		Ken Acker	27
Webster	TX	77598	(713) 338-2652		Quintin Stokley	28
Birmingham	AL	35210	(205) 956-6751		Don Hamner	29
Wichita	KS	67218	(316) 686-4087		Chris M. Hearn	30
Northbrook	IL	60062	(312) 564-3330		W.B. Rivkin	31
Goleta	CA	93017	(805) 685-2612		John Handloser	32
Tigard	OR	97223	(503) 620-6617		Ross Mercer	33
Rockville	MD	20850	(301) 670-1818		Larry W.Camper/Catherine Haney	34
Arlington	TX	76012	(817) 261-5566		Larry J. Stephenson	35
New Lenox	IL	60451	(815) 485-6161		Stan A. Huber	36
Castle Rock	CO	80104	(303) 394-8289		Geoffrey S. Ibbott	37
Seattle	WA	98102	( ) 323-0620		Ron Soper	38
Amelia	LA	70340	(504) 631-0354		Don Ducote	39
Oxford	MS	38655	(601) 232-5322		James J. Reidy	40
Louisville	KY	40223	(502) 588-5231		Ahren Jacobson	41
Towson	MD	21204	( )			42
Nashville	TN	37210	(615) 883-9760		Vivian Denton	43
Cleveland	OH	44139	(216) 248-0400	x276	Rick L. Thompson	44
Houston	TX	77266	(713) 667-8813		B. J. Zachary	45
Sweetwater	TX	79556	(915) 235-5494		Paul Fritz	46

Company Identification Information

Line Number	Company Name	Company Name (cont.)	Address
47	Murray Lures		704 L Street
48	Medi-Ray, Inc.		150 Marbledale Road
49	Medical & Radiation Physics, Inc.		P.O. Box 790925
50	Mid-Atlantic Radiation Physics, Inc.		10408 Truxton Road
51	Midwest Calibration Center		5213 West Lawrence
52	Midwest Radiation Protection, Inc.		2518 East 8th Street
53	Jerry D. Morris		Route 1, Box 35B
54	Morrison-Knudsen Co., Inc.	Safety Department	P.O. Box 7808
55	mR Services, Inc.		476 Kenton Street
56	The NDL Organization, Inc.		1000 Lower South Street
57	Newco, Inc.		160 North Edisto Drive
58	NMA-Medical Physics Services		9700 Garfield Blvd.
59	Nuclear Consulting Services, Inc.		P.O. Box 29151
60	Nuclear Instrument Co.		65 Grove Street, P.O. Box 178
61	Nuclear Sources & Services		P.O. Box 34042
62	Neutron Products, Inc.		22301 Mount Ephraim Road, Box 86
63	Office of Emergency Services		2800 Meadowview Road
64	Perry Radiological Consulting, Inc.		1150 Byronell Drive
65	Physics Associates		5346 Peters Creek Road, N.W.
66	Professional Radiation Services Corp.	(Shipping: 3101 Brownsboro Rd.)	P.O. Box 6091
67	R/A Services		P.O. Box 7345, 9407 Co. Road, 128 W
68	Radcal Corp		426 Duarte Road
69	Radiation Consultants of Mid-America, Inc.		5500 Buena Vista
70	Radiation Consultants, Inc.		P.O Box 34012
71	Radiation Consulting Associates, Inc.		992 N.W. 80th Avenue
72	Radiation Instrument Calibration Laboratory	Illinois Department of Nuclear Safety	525 West Jefferson
73	Radiation Protection		6521 Beach Drive, S.W.
74	Radiation Safety Engineering, Inc.		7713 South Butte Avenue
75	Radiation Safety Services, Inc.		1564 Ashland Avenue
76	Radiological Calibration Services, Inc.		2763 Rosewood Drive, P.O. Box 50736
77	Radiological Physics Services, Inc.		3348 East Mercer Lane
78	Radiology Association of Macon		770 Pine Street, Suite L-20
79	Reuter-Stokes		8499 Darrow Road
80	St. Mary's Hospital and Medical Center	Radiation Oncology Department	2635 North 7th Street
81	Schneider & Wuest, Inc.		304 Mulberry Street
82	SIMCO Electronics		382 Martin Avenue
83	G. E. Smith & Associates, Inc.		919 Herbert
84	Source Production and Equipment Co., Inc.		625 Oxley Street
85	South Arkansas Radiation Therapy Institute		503 Thompson
86	Standard Nuclear Consultants, Ltd.		1S016 Donny Hill Road
87	Sun Nuclear Corporation		415-C Pineda Court
88	Syncor Instrument Corp.		20001 Prairie Street
89	Teledyne Isotopes		50 Van Buren Avenue
90	University of Utah	Radiological Health	100 OSH, University of Utah
91	University of Washington	Environmental Health & Safety GS-05	Northwest Radiation Inst. Cal. Fac.
92	R. M. Wester & Associates, Inc.		215 Indacom Drive
93	Robert Wilson		513 Fleda

Company Identification Information

City	State	Zipcode	Phone	Ext.	Contact	Line Number
Burling	AR	72423	(501) 452-4881		Thomas Murray	47
Tuckahoe	NY	10707	(914) 961-8484		Mary Benjamin	48
San Antonio	TX	78279 0925	(512) 341-4525		D. L. Goff/R. J. Watts	49
Adelphi	MD	20783	(301) 434-9283		Dwight W. Glenn	50
Chicago	IL	60630	(312) 282-1689		Nick Lembares/James Peterson	51
Bloomington	In.	47401	(317) 494-1435		Paul L. Ziemer/Henry C. Briggs	52
Columbia	MS	39429	(601) 736-3630		Jerry D. Morris	53
Boise	ID	83729	(208) 386-5564		Bruce H. Peterson	54
Aurora	CO	80010	(303) 303-8333		Philip Morton	55
Peekskill	NY	10566	(914) 737-7330		Alan Jones	56
Florence	SC	29501	(803) 669-2988		Frank Zastawnik	57
Garfield Heights	OH	44125	(216) 641-5799		Paul Early	58
Columbus	OH	43229	(614) 846-5710		W. Peter Freeman/Bela Kovach	59
Rockland	MA	02370	(617) 878-6878		Carl J. Borsari	60
Houston	TX	77234	(713) 641-0391		Robert D. Gallagher/Charles T. Gallagher	61
Dickerson	MD	20842	(301) 349-5001		Wayne J. Costley	62
Sacramento	CA	95832	(916) 427-4013		Richard Powers	63
Mobile	AL	36609	( )		Nelson	64
Roanoke	VA	24019	(703) 563-0165		Lee S. Anthony	65
Louisville	KY	40206	(502) 895-2755		O. R. Czerwonka	66
Odessa	TX	79760	(915) 563-4127		Robert Calley/Debby Oprea-Wright	67
Monorvia	CA	91016	(818) 359-4575		Dave Lansverk	68
Shawnee Mission	KS	66205	(913) 236-5126		R. Emory Larimore	69
Houston	TX	77234	(713) 943-9613		Bruce Bristow	70
Hialeah	FL	33016	( )		John McCollough	71
Springfield	IL	62761	(217) 785-4174		Apparao Devata	72
Seattle	WA	98136	(206) 655-0500		William E. Morgan	73
Tempe	AZ	85284	(602) 897-9459		R. Metzger	74
Evanston	IL	60201 4070	(312) 866-7744		Eli Port	75
Columbia	SC	29250	(803) 733-0836		Jack Cox	76
Phoenix	AZ	85028	(602) 966-1685		John A. Hicks	77
Macon	GA	31201	(912) 743-3466		Wilson D. Drew	78
Twinsburg	OH	44087	(216) 425-3755		Robert B. Speed	79
Grand Junction	CO	81501	(303) 244-2140		David A. Thompson	80
Perrysburg	OH	43551	(419) 874-5947		Andreu Schneider	81
Santa Clara	CA	95050	(408) 727-3611		Carl L. Quinn	82
Pasadena	TX	77506	(713) 475-2986		Gerald E. Smith	83
Kenner	LA	70062	( )		R. Dicharry	84
El Dorado	AR	77730	(501) 864-0318		Mett Kawalski	85
Elburn	IL	60119	(312) 365-5858		Stan Buhr/Jim Mikowski	86
Melbourne	FL	32940	(305) 259-6862		William E. Simon	87
Chatsworth	CA	91311	(800) 423-5620		Jack L. Coffey	88
Westwood	NJ	07675	(201) 664-7070	x230	Jeffrey M. Guenther	89
Salt Lake City	UT	84112	(801) 581-6141		R. J. Hoffman/Keith J. Schiager	90
Seattle	WA	98195	(206) 543-0463		Carl G. Riches	91
St. Peters	MO	63376	(314) 928-9628		Robert M. Wester	92
Memphis	TN	38119	(901) 682-7247		Robert Wilson	93

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Directory of Calibration Services for Ionizing
Radiation Survey Instruments

5. AUTHOR(S)

H. T. Heaton

6. PERFORMING ORGANIZATION *(If joint or other than NBS, see instructions)*

NATIONAL BUREAU OF STANDARDS
U.S. DEPARTMENT OF COMMERCE
GAITHERSBURG, MD 20899

7. Contract/Grant No.

NB80NANA1046

8. Type of Report & Period Covered

Final

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)*

Conference of Radiation Control Program Directors, Inc.
71 Fountain Place
Frankfort, KY 40601

10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)*

This directory provides information about calibration services for ionizing radiation survey instruments. Its basic purpose is to tell the owner or user of a survey instrument where a calibration might be obtained. After introductory definitions of critical terms and a general description of quality assurance programs, available calibration services are listed. First, a summary of services is provided in which companies are listed alphabetically by company name and also alphabetically by state. Then a detailed list of services is provided for each type of radiation used to perform a calibration: alpha particles, beta particles, gamma rays, neutrons, and x rays. The final list shows the name, address, phone number, and person to contact for each company included in the directory. Information is presented as provided in a questionnaire returned by each company. No attempt has been made to verify the information provided, and inclusion of a company in the directory does not constitute endorsement by the publisher or approval by any licensing authority.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

calibration; commercial services; directory; ionizing radiation; quality assurance; radiation; radiation measurement; radioactive sources; survey instruments

13. AVAILABILITY

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